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CR-133138

SURVEY OF LAKE FLOODING FROM

ERTS-1: LAKE CHAMPLAIN

(E73-10771) SURVEY OF LAKE FLOODING
FROM ERTS-1: LAKE CHAMPLAIN (Vermont
Univ.) 11 p HC \$3.00 CSCL 08H

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SR 347

CONTRACT NO: NAS 5-21753

UNIVERSITY OF VERMONT
REMOTE SENSING LABORATORY
DEPARTMENT OF GEOGRAPHY

BURLINGTON, VT. 05401

Original photography may be purchased from:
ERS Data Center
10th and Dakota Avenue
Sioux Falls, SD 57198

JUNE 1973

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This constitutes a significant result
report on NASA resource categories 4.F,
Flood Assessment and 4.D, Limnology.

RESOURCE PROBLEMS AND LAKE LEVELS

Seasonal lake-level changes in Lake Champlain have recently been a topic of much concern among various resource management bodies and local shore residents since above-normal and record high lake-levels have caused flooding problems in low-lying areas affecting both agricultural and resort activities as well as lake transportation. In addition, wildlife habitats in major preserves such as in the delta region of the Lamoille River have been adversely affected by the high lake-levels.

Seasonal lake-levels may vary by as much as nine feet (2.74 meters) with the highest levels coming during the spring months as snow melt combines with runoff from frontal rains. The heavy spring runoff is rapidly reflected in lake levels which attain their highest mark in April when they may reach or exceed the 100-foot level.¹ Above normal precipitation has combined with the spring runoff to bring about generally high lake-levels through the course of the year, and this has prompted some interest in adopting controlling measures for regulating lake-levels. Since the outlet of Lake Champlain is the Richelieu River in Canada, such questions become the jurisdiction of the International Joint Commission. This body has resource management powers and it has begun studies relating to the problem. The Lake Champlain Commission is another agency with an interest in lowland flooding. Among the kinds of information that will be needed are: 1) nature and extent of inundations 2) seasonal lake volume differences and 3) shore changes resulting from lake-level changes. These questions are essentially interdependent and it was anticipated at the outset of this ERTS investigation that satellite imagery, with its synoptic feature of viewing a large area at one time and its periodic coverage, might become a viable tool for lake-level investigations. The recently received April ERTS coverage of Lake Champlain has provided the seasonal contrast desired. Seasonal differences between low lake-levels occurring in October of last year and high lake-levels of the following spring (April, 1973) amount to nearly 5 1/2 feet (1.67 meters). These differences are readily apparent on ERTS imagery and will form the basis for a lake-wide survey of flooding and shoreline change.

¹Datum for lake levels is mean sea-level.

ERTS IMAGERY

The seasonal imageries used to assess inundation and shoreline change include autumn and spring scenes which reveal substantial changes in lake level. The well-known property of water to fully absorb near-infrared energy while contrasting land areas tend to reflect such energy in varying amounts leads to a maximum contrast between land and water reflectivity in the infrared bands. Thus, imagery derived from remote sensors using the near-infrared will show water areas as featureless dark gray and land in contrasting medium to light gray when presented on positive film. The infrared bands of ERTS-1 currently in use include MSS bands 6 and 7 (.7 - .8 and .8 - 1.1 μ m respectively) and it is imagery from these bands that provides the best data for the monitoring of lake levels.

The images used to demonstrate the utility of ERTS imagery for lake-level determinations and flood assessment were obtained on October 10, 1972 (low lake-level). These include image numbers 1079-15115, 1258-15071 and 1276-15070 respectively. On October 10, the lake level recorded at the Lake Champlain Transportation Co. gage in Burlington harbor was 95.1 feet (28.99 meters). The higher, spring lake-levels amounted to 100.4 feet (30.60 meters) on April 7 and 99.4 feet (30.30 meters) on April 25. These were also recorded at the Burlington gage mentioned above.

The major changes in shoreline position resulting from the above lake-level changes are most spectacular along low gradient shores such as in deltaic terrain. As the shore gradient steepens, the horizontal displacement becomes smaller. The two examples presented below show a deltaic environment and a steeper gradient shoreline having an estuarine configuration. The former is the Lamoille River delta in Chittenden County while the latter shows the mouths of the Otter Creek-Dead Creek drainage in northern Addison County. Figures 1, 2, and 3 illustrate the seasonal changes in the Lamoille delta region while Figures 4, 5, and 6 show contrasting seasonal changes in northern Addison County.

The images presented in this report are 4 X enlargements made with Polaroid MP-3 equipment and Type 55 P/N film, printed on high contrast photographic paper. The scales on the images are virtually identical at 1:125,000 or one inch equals two miles. Data base was the standard 9 $\frac{1}{2}$ inch positive transparency.



Figure 1. The Lamoille River delta on 10 October 1972 with lake stage at 95.1 ft. (28.99 meters). This MSS band 7 scene is enlarged to a scale of 1:125,000.

All following figures are the same scale.



Figure 2. The Lamoille River delta almost completely inundated on 7 April 1973 with lake stage at 100.4 ft. (30.60 meters).



Figure 3. The Lamoille River delta region on 25 April with slightly lower lake stage than shown in Figure 2 (99.4 ft. or 30.30 meters). Somewhat more land has emerged with only shallow inundation in areas that were more deeply inundated previously.

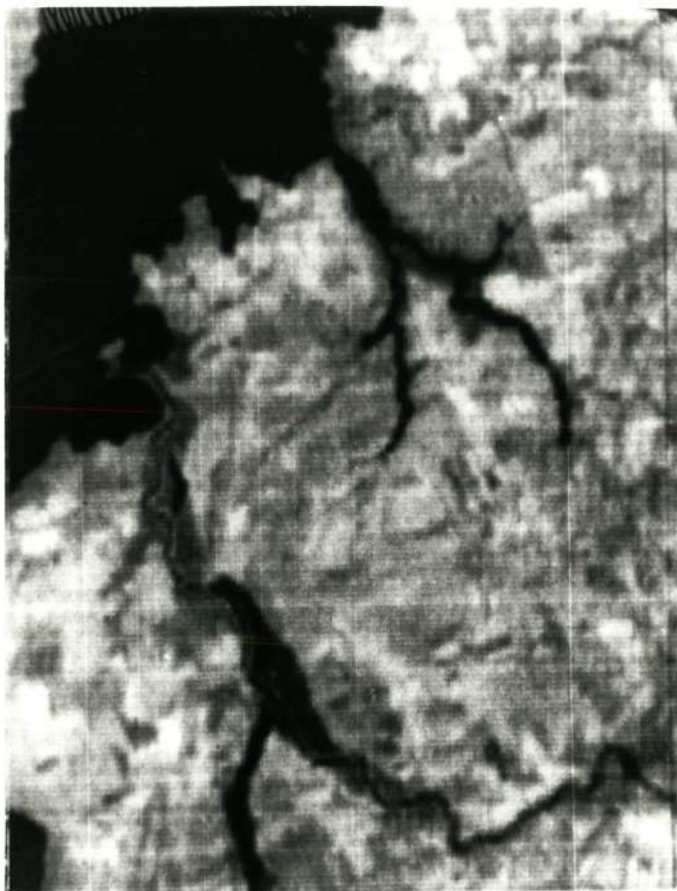


Figure 4. The Otter Creek-Dead Creek area in Addison County has low to moderate shore gradients with wetlands. The scene shows low water conditions of October 10.

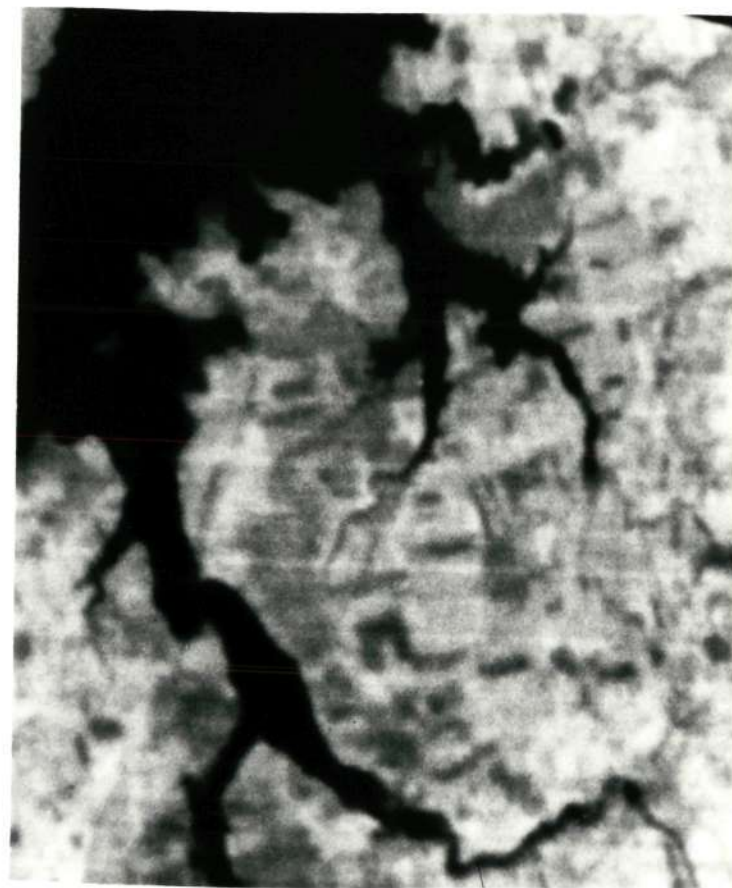


Figure 5. The Otter Creek-Dead Creek area on 7 April 1973 (high water) showing substantial inundation and shoreline change. Some agricultural land and seasonal residences are affected.

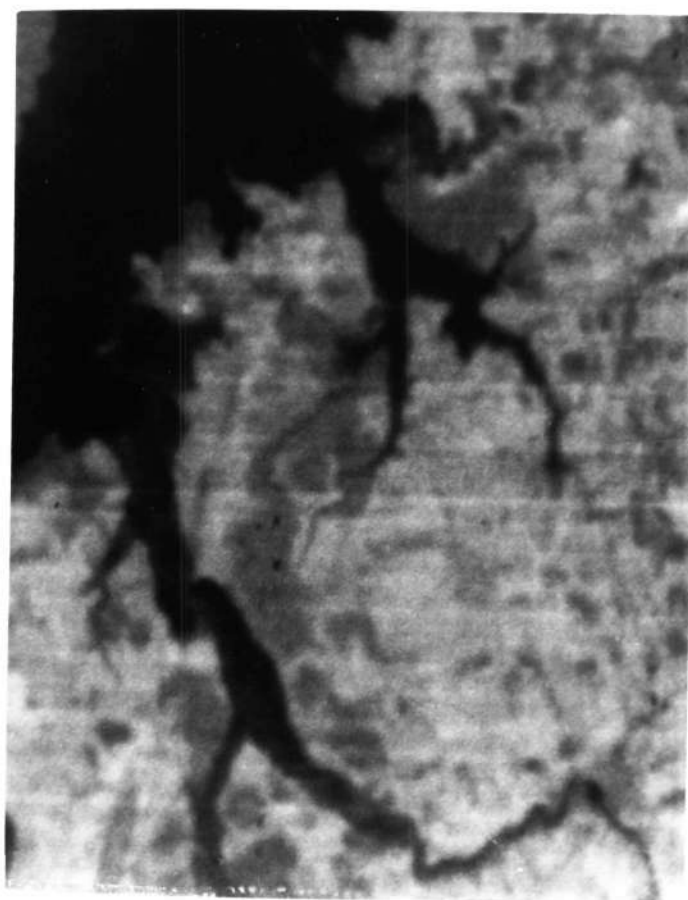


Figure 6. The Otter Creek-Dead Creek area on 25 April showing additional changes due to a slight drop in water level.

The extent of inundation in the Lamoille River delta with the lake level at 100.4 feet (30.60 meters) is virtually complete (Figures 2 and 3). Only river-bank levees and sand bars remain above water level. The light toned "point" showing in the April imagery is a portion of Sand Bar State Park. The remaining portion of the park was inundated. With about a 1-foot (0.3 meter) recession in lake level (April 25), more areas emerge as indicated by expansion of the lighter tones along the river banks.

The Otter Creek-Dead Creek area is characterized by a moderately to gently sloping shore gradient resulting in less horizontal change in shoreline as lake level changes. However, seasonal changes are readily apparent by comparison of the ERTS scenes and slight changes in level such as occurred between April 7 and April 25 are also detectable. In this area, cropland has been inundated besides the generally low wetlands found in the valleys.

Preliminary experiments indicate these shoreline changes can be plotted directly onto existing U.S. Geological Survey topographic maps with little difficulty. These shoreline plots provide information that was not possible to obtain previously since topographic information on existing maps is insufficient to locate projected lake levels from gage data alone. Since ERTS has provided a basis for assessing flooding and shoreline change, the areal extent of these can now also be mapped and applied in resource management decisions.

SUMMARY AND RESOURCE SIGNIFICANCE

The resource questions identified at the outset of this report included lake-volume changes, shoreline change and flooding extent. These questions were raised because of major concerns on the part of resource management bodies and local governments regarding the above normal lake-levels which have characterized the past 3 years. Factual information is now needed in order to deal with such questions. Data supplied by ERTS-1 seems to have particular relevance to these resource questions since shoreline change and hence lake-level change can be readily observed from enlargements of specific scenes. The most useful wave-length bands are MSS bands 6 and 7 (.07 - 0.8 and 0.8 - 1.1 μ m respectively) which provide maximum land-water contrast.

Other resource questions now being raised at the State level include lake-shore zoning and land-use regulations. It is anticipated that ERTS data on lake-level changes would have an important bearing on such provisions, at least for the larger low-lying tracts.

SIGNIFICANT RESULT SUMMARY

4.F. Flood Assessment

4.D. Limnology

ERTS-1 Imagery showing seasonal lake-level conditions in Lake Champlain can be used to assess shoreline change and flooding extent. MSS bands 6 and 7 (0.7 - 9.8 and 0.9 - 1.1 μ m) provide maximum land-water contrasts and are the most useful for shoreline location. Shoreline changes observed between ERTS coverages of October 10 (low water) and April 7 and 25 (high water) are readily apparent and enlargement of specific scenes by 4 X provides data which can be transferred to a map base. The unique synoptic view provided by ERTS-1 will make it possible to map shoreline positions occurring at a specific lake stage. Due to present governmental concerns over abnormally high lake levels, resource management questions have been raised regarding the extent, nature and occurrence of inundation, magnitude of shoreline change and lake volume change. It is anticipated that ERTS-1 data will provide useful information for these purposes.

ERRATUM

Last sentence page 2. Add: Data base was the standard
9 1/2 inch positive transparency.

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